

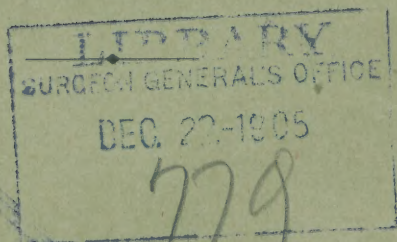
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EXPERIMENTAL COLLES' FRACTURE



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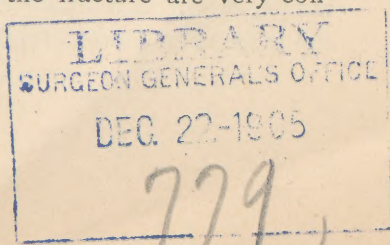
In spite of the vast deal that has been written on the mechanism of production of Colles' fracture, the question seems not yet fully settled. It has been proved possible, experimentally, to fracture the radius near the wrist, either by pressure and counterpressure exerted in the long axis of the arm, or by forcible hyperextension, the force then being applied to the radius through the anterior carpal ligament, the hand acting as a lever. The possibility of the latter mechanism—the so-called fracture by arrachement—was long ago demonstrated by Bouchet and confirmed by many experimenters since his time. Many surgeons have accepted the theory, largely because it seems to explain the constant site of the fracture. This constancy, however, has been amply explained by Lopez and Hennequin, who show that the radius supported by the ulna through the strong interosseous ligament higher up must give way near the wrist, even under simple direct force. This argument for the theory of arrachement seems, then, of no weight.

The arguments against the theory have been: first, that it implies a position of the hand in falling that does not correspond to the usual account of the accident—that is, a fall forward on the hand; secondly, that the experimental evidence is not quite satisfactory.

Many experiments have been made, but have not usually been reported in such detail as to be of great value.

It seemed to me that a comparison in detail of fractures produced by the two mechanisms with the lesions recorded in actual Colles' fracture might be of value.

The lesions of Colles' fracture are subject to considerable variation, but certain features of the fracture are very constant.



There are data enough to justify positive conclusions in this respect, data from a number of dissections of fresh cases, from the examination of many museum specimens and many X-ray photographs. I will not here go into the pathology, but would emphasize two points for comparison.

Where the line of fracture shows any obliquity anteroposteriorly, this is, with extremely rare exceptions, oblique upward and backward.

Where there is comminution, there is, as Packard and Bennett have shown, a relatively constant arrangement in the lines of penetration into the wrist-joint. These are described by Bennett as follows: "A fissure, starting from the same point in the ulnar facette, runs into the carpal articular cartilage along its posterior edge, breaking out into the dorsal surface of the bone, either, in the least extensive injuries, at the outer side of the common extensor groove, or, in others, running along as far as the groove for the radial extensors, and in a few breaking out at each of these points."

In some "a branch is traced passing from the first fissure towards the anterior depression in the scaphoid facette."

The experiments, which I was enabled to carry out by courtesy of Dr. Dwight, were performed as follows:

For the action of opposing forces were used:

(1.) Blows with a mallet on the palm of the hand, the arm being fixed.

(2.) Blows on the elbow, the hand being fixed so as to ensure against hyperextension, the arm slightly oblique.

(3.) By a lever machine, which gave the same direction of forces.

For the leverage in hyperextension were used:

(1.) Blows on palm and fingers of the extended hand, the arm being fixed.

(2.) In a few cases pressure of lever on metacarpus and fingers, the elbow being supported.

Nearly 40 attempts were made, some of which resulted in failure through crushing of the elbow directly beneath the mallet, or through other fracture than Colles' resulting; but the more usual cause of failure was rupture of the ligaments,

especially the anterior carpal ligament in hyperextension, since the subjects experimented on were partly dissected, and the ligaments somewhat too dry to reproduce natural conditions. In some few cases fracture of the carpus resulted, especially of the scaphoid, which fracture, by the way, seems, in the light of the recent X-ray data, more frequent as an accompaniment or equivalent of Colles' than was formerly supposed. Of satisfactory results to be used in comparison there were but 10, — 7 produced by pressure and counter-pressure, 3 by hyperextension. The exact detail of applying the force seems to have been immaterial.

The detailed results are shown in these diagrams.

Of the fractures under breaking strain, two were perfectly typical cases of the simple Colles' oblique upward and backward.

Two were comminuted, with precisely the lines of comminution into the joint found by Bennett in his series of specimens.

One showed the characteristic line, but the fracture included only a part of the thickness of the radius.

One showed fracture of the radial styloid, with splintering upward of the bone of no especial type.

In two of these the ulnar styloid was fractured at its base.

In no case was there impaction.

Of those produced by hyperextension there was in no case any comminution. In no case was the whole thickness of the bone involved, but the fracture consisted in the lifting off of the anterior portion of the bone by the anterior ligament, the fracture line extending obliquely downward and backward into the joint. The line of penetration into the joint was in two cases directly transverse, a line I have not seen noted clinically. In the third the line was oblique and emerged further back.

We have, then, in this series all seven fractures produced by breaking strain showing a correspondence even to details, with forms usual in actual Colles' fracture; while the three produced by hyperextension all show the reversed Barton's fracture, a form of which Roberts, in a very full paper on

reversed Colles', says it "must be excessively rare at the anterior margin of the radius, since they are almost unknown even in the fracture with posterior displacements."

How far one may argue from the lines of fracture into the joint in deciding mechanism is hard to say, but their relative constancy precludes any explanation of accident. Bennett thought them the result of splitting by the upper fragment of the lower fragment at its thinnest part, but it is equally conceivable that the thrust up and back of the carpal bones against the projecting posterior lip of the radius may be the cause. In this connection spec. 1037 of the Warren Museum is of interest, where there is no transverse fracture; yet these lines are exactly reproduced on the joint surface, it would seem certainly by impact of the carpus.

Probably the mechanism of Colles' is not always the same. Certainly there seem to be clinically a very few well-established cases of some sort of fracture like Colles' occurring through hyperextension, and probably Löbker is right in believing that arrachement may often play a part, though subordinate. Whether the anterior carpal ligament is the important factor, whether the strain of the stretched flexor tendons may not be more important, is of course undecided.

As to the alleged frequency of fracture by hyperextension, however, the present series argues strongly against it and for the production by breaking strain, bearing out fully the statement of Stimson that "the resemblance between the fractures produced experimentally by overextension and those caused by falls during life is by no means so close as has been asserted."

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